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ABSTRACT

In July 1999, the Board of Studies in New South Wales released five new senior high school science syllabi for implementation in 2000. The study reported in this paper examines the perceptions of a small group of experienced biology teachers towards syllabus change and in particular those concerning the Stage 6 Biology syllabus for the Preliminary course. Discussion of nature of biology and its teaching and the practicalities of biology lessons were used as tools for accessing teachers' thinking about syllabus change. (Contains 12 references.) (Author)

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HSC Biology Teachers and the Stage 6 Syllabus

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Abstract

In July 1999, the Board of Studies in New South Wales released five new senior high school science syllabi for implementation in 2000. The study reported in this paper examines the perceptions of a small group of experienced biology teachers towards syllabus change and in particular those concerning the Stage 6 Biology syllabus for the Preliminary course. Discussion of nature of biology and its teaching and the practicalities of biology lessons were used as tools for accessing teachers' thinking about syllabus change.

Introduction

During the early 1990's discussion concerning changes to the NSW Higher School Certificate (HSC) highlighted the need to provide all students with an education more suited to their academic, social and cultural needs. As a result of changing economic and social circumstance, greater numbers students were remaining within the formal school system and completing studies towards gaining the Higher School Certificate. For those students more suited to non-academic work the formality of the HSC was inappropriate and a concern for teachers. This concern was for science teachers manifested in the need to provide students with an education in science in keeping with their interests and academic abilities whilst continuing to portray science as a corpus of ever changing understands about the world. Two publications from the Board of Studies were the basis for shaping the New Higher School Certificate (2000). These were the McGraw (1997), *Shaping their Future* , followed by the HSC White Paper (1997), *Securing their Future: The NSW Government's reforms for the Higher School Certificate* .

Formal planning for change in science education on the part of the Board of Studies NSW (BOS) began in 1997. Together with members from the NSW Science Teachers' Association, the NSW Department of Education and Training and tertiary science educators working in teacher education, the Board of Studies held a science symposium at St Mary's High School, a local Sydney metropolitan government secondary school, in November 1997. This symposium sought advice from participants about the nature of science teaching at Stage 6 and the content which might be presented to students during the last two years of secondary education. In addition, the BOS conducted a literature review of current national and international science education research pertaining to best practice and curriculum development. Recommendations specific for biology included consideration of a course of study which reflected the integration, sequence and continuity of biological concepts with an emphasis on biochemistry, physiology and ecology along with diversity and the origin of life, biodiversity, ecology, DNA/molecular biology, maintenance of life through regulation and homeostasis, energy in biological systems, what constitutes a balanced environment, the unique role of people in nature and finally, the biological and psychologically integrated human body (Board of Studies, 1998) . During the later half of 1998, the Board of Studies began the preparation of working drafts for each of the five Stage 6 syllabi, using expertise from Board of Studies members, Board Curriculum Committee members, science teachers and other key groups including tertiary science educators, science academics and interested persons from industry. A draft syllabus package for biology was sent to all NSW high schools for comment and responses sought from teachers during late March/April 1999. The final Stage 6 Biology syllabus along with all other HSC syllabi was given NSW governmental approval in June 1999 and released to schools along with support documents in July 1999 for implementation in 2000.

In NSW for students to be awarded the Higher School Certificate, they must complete six years of full time secondary education and present themselves for public examination in a variety of academic subjects including English, the only mandatory subject. Generally students undertake 10-12 units of study. Students with a keen interest in science may take up to 6 units in science with remaining units for example taken in English and Mathematics. The Stage 6 syllabi in science are Biology, Chemistry, Physics, Earth and Environmental Science and Senior Science with each course divided into two years of study. The first known as the Preliminary Course provides students with the conceptual understanding and skills necessary for the Higher School Certificate Course, the second year of study. It is only the HSC course which is examined at the final examination.

The Study

The research reported in this paper is part of longitudinal ethnographic study of experienced HSC biology teachers and their perceptions of the Stage 6 Biology syllabus. This paper details the perceptions of a small group of experienced biology teachers regarding the new Stage 6 Biology syllabus implemented into schools in January 2000, the beginning of Australian academic school year. Specifically, the study sought to determine the impact of the Preliminary course on teachers and their current classroom practice and, how the Stage 6 biology syllabus document was used by them to provide students with a holistic view of biology. In addition views were sought from participants on the nature of biology and its teaching at the senior secondary level.

The perspective that HSC biology teachers have about their subject and how it ought to be presented to students has not been reported in the literature nor addressed at professional conferences. Despite the considerable body of research literature about the development and implementation of curriculum programs in science whose specific aim is to portray to students and to teachers, the distinctive nature and currently accepted views on the nature of science, the role and perspective of teachers is given little significant consideration. Few studies exist whose aim is to elucidate the role, contribution and perspective teachers could make with respect to syllabus development and implementation, and the importance this plays in student learning.

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The research sought to address the following questions:

- How do HSC biology teachers perceive and articulate their experience of potential/real curriculum change? Specifically, how does change impact on classroom practice?
- In what ways do teachers vary in their perceptions and experience of curriculum change within and between schools?
- How do teachers construct their professional identity?

Given that the researcher wanted to gain access to teachers' thinking about syllabus change over an extended period of time, a methodology was sought which would provide insights into the meaning of change for teachers and how notions of change were used in their sense-making process. Opportunities to participate in research are uncommon for most teachers. The aim was to gain access of teachers' world individually and as a group within the same bounded social context, that is, classroom practice. This led to the following principles of research design.

First, teachers were conceptualised as expert practitioners whose contributions to this study were valued for their clear, rational, considered and logical perspective. Such a perspective required the adoption of a phenomenological stance - free from pre-conceptions and expectations on the part of the researcher (Schutz, 1990, Brown and McIntyre, 1993, Silverman 1997).

Second, the study had to be relevant to teachers and conducted in a manner which was non threatening, non judgemental and thus seen by them as a window of opportunity to converse with an impartial professional colleague. Even though participants knew the researcher she was neither a fellow staff member nor associated with the Board of Studies NSW, the Department of Eduction and Training or any other teacher employer. This provided participants with a unique opportunity to articulate their thinking and present their considered opinions about syllabus change.

Third, in order to collect sufficient data which might reflect teachers' notions of change and how this itself might change over time, semi-structured interviews were undertaken which focused on the syllabus and its implementation, in-school programming, professional support from BOS and DET, teaching resources such as the Internet and data loggers and finally, student performance and assessment. Interviews took place at school at a time convenient to the participant; usually these were out of school hours.

Fourth, data ownership and control lay with each participant. In this study, teachers were provided with focus points for each interview and invited to comment on each of these and others of their choosing during data collection. Transcripts were made available and teachers invited to reject or modify any comments.

Fifth, data analysis began with preliminary analysis of the first interview without the use of predetermined theoretical categories and concepts. This would allow for the emergence of analytical themes from the data and at least a tentative move from a situated to a general description on the change phenomena. The researcher's aim was to unravel the structure of meaning in the change phenomena by moving from the observed to the theoretical essence of meaning.

Data Collection

Data was collected in the form of semi-structured interviews of one-hour duration and document analysis both in paper and electronic format. The first of five interviews was conducted at the end of 1999 when the Stage 6 Biology syllabus and related support documents had been in school for several months. For those teachers working in government schools, in-service courses to assist them with syllabus implementation were under way with many teachers availing themselves of this opportunity. Concurrently, the Department of Education and Training, the Catholic Education Office, the Association for Independent Schools and the NSW Science Teachers' Association had begun the task of programming the Preliminary Course, copies of which were available on the Internet from December 1999. In addition a wealth of information pertaining to the syllabus became available from various universities and from the Australian Academy of Science.

The pre-implementation interview explored teachers' understanding of the 2-unit Biology syllabus (1994) and the Stage 6 Biology syllabus (2000). It focused on syllabus rationale, aims and objectives, subject matter and outcomes based assessment. In addition, teachers were invited to articulate their thinking about the level and availability of professional support, their ownership and involvement with the development of the Stage 6 Biology syllabus and finally their more personal hopes and expectations for students and themselves. The second interview sought teachers views about the Preliminary course to date with many teachers having completed two of the four mandatory units, students' understanding of various biological concepts, use of information technology (IT), unit programming and availability of professional support. All interviews were transcribed and individual transcripts made available to participants for comment and corrections. Data collection remains on going as seen below.

Time Line for Interviews

Date	Purpose of Interview
November/December 1999	Pre-implementation
April/May 2000	Preliminary course - initial
November/December 2000	Preliminary course - final HSC - initial
July/August 2001	HSC course - final
February/March 2002	HSC examination

The researcher is presently undertaking the first round of data collection for the HSC course which began in September 2000. The second round of data collection for the HSC course will be conducted in July/August 2001 when the HSC course will have been completed by most students. The

initial cohort of students will be examined in October 2001 with results released to students and schools in December. Final interviews with teachers will be conducted early in 2002 with a focus on the HSC examination, assessment and student performance.

The Participants

In terms of teacher selection, a choice had to be made between beginning or experience HSC biology teachers. Because the research was in part addressing what teachers thought about major changes to biology teaching, it was felt that experienced teachers alone would be a more suitable sample rather than beginning teachers or some combination. It was not the assumption that experienced teachers would somehow, as a result of their teaching experience, have a more comprehensive or sophisticated view of biology teaching. Rather it was simply that the researcher was interested in the notion of change, how this had affected experienced teachers in the past and how change might impact on classroom practice in the future.

The second decision concerned the nature of the sample and its size. Because of the variety of schools within NSW and given that all students who present themselves for the HSC are examined by the same syllabus board, in this case the Board of Studies NSW, it was important that teachers be selected from schools which as far as was practically possible, reflected the diversity and balance of student groups and schools. For practical reasons schools were selected from a radius of 30 kilometres from the researcher's place of work. All teachers had between ten and twenty five years of biology teaching experience and were conversant with the previous HSC syllabus. Those teachers with the most experience had taught up to three different syllabi during their teaching career. Many had taught in more than one school and considered a diversity of teaching experiences essential to their ongoing professionalism. In addition, participants had been involved as supervising teachers for beginning science teachers and were therefore known to the researcher. Thus, teachers were selected on the basis of their willingness to participate and the nature of their school and student body.

Given the wealth of data generated by semi-structured interviews and taking into account possible teacher attrition, fourteen practicing biology teachers participated in the first and second round of interviews for the 2000 Preliminary year. Apart from one teacher who worked in a girls private school, all teachers were currently working in government secondary schools - five in comprehensive high schools, two in academically selective and four in non-academically selective schools, one in a boys comprehensive school and one in a school where 85% of students came from non-English speaking backgrounds. Fewer teachers would still have provided the same richness of data but might well not have provided the diversity of coverage. The work of Miles and Huberman (1994) is helpful in this context:

> ... with much recent practice to support us, ... multiple cases offer the researcher an even deeper understanding of processes and outcomes of cases, the chance to test (not just develop) hypotheses, and a good picture of locally grounded causality. (p. 26)

Indeed multiple cases increase confidence in research findings if cases are examined for their similarity and differences (*ibid* ., p. 29).

Findings and Discussion

Overview:

Teachers in this study were confident about all aspects of their biology teaching relating to the 2-Unit Biology syllabus (1994). They reported in detail about how they endeavoured to present the content of the syllabus to students as part of a holistic view of biology. What was particularly distinctive about these teachers was the variety of approaches to biology teaching necessitated by the diversity of students - academically, socially and culturally. Despite their own backgrounds often being quite different from their students, teachers looked upon biology teaching for the most part as an enjoyable professional challenge. The ability to prepare and implement biology lessons suitable for all student groups was viewed as an essential element of their teaching and so formed an integral part of their professional identity. That syllabus change was 'in the wind' was welcomed by most participants and seen as essential given the nature of biological research and the need to keep up to date with developments within the discipline. What did concern many participants was the pace of change rather than the amount of change. The fact that the syllabus document and related support materials, either in hard copy or in electronic form, were either not immediately available or delayed and thus along with a lack of adequate professional support were seen by teachers as unhelpful. Frequent mention was made of teachers' perceived lack of involvement with the draft syllabus. Many commented that staff had spent a considerable amount of time examining its aims, objectives and outcomes and had provided the Board of Studies with their considered opinions and suggestions for improvement only to come to the realisation that these were not considered as evident in the final format of the Stage 6 Biology syllabus. Of particular concern in the first interview was the amount of biological content which needed to be understood by students. This was revisited by participants in subsequent interviews where concern was raised as to the depth of coverage required. In the past teachers had used past examinations as a guide to breadth and depth of content - this was now unavailable.

Teachers viewed changes to the HSC syllabus as essentially driven by politics and government regulations which the Board of Studies implemented. Many believed that the government along with other stakeholders in education were insensitive to the needs of teachers. This was of particular concern to science teachers who were also implementing major changes to the teaching of science at Stages 4/5 along with those at Stage 6. Lack of substantive professional support at a time of need reflected the government's insensitivity to the teaching profession. Despite these difficulties teachers welcomed change.

Discussion will now focus on the 2-Unit Biology syllabus (1994) and the Stage 6 Biology syllabus (1999). Teachers' perceptions of syllabus change and what it means to them both professionally and individually are embedded within the two following sections.

The 2-Unit Biology syllabus (1994)

For many teachers this syllabus had a number of advantages. The sequence of units and the arrangement of content allowed students to learn about biology in a logical and well ordered manner. For example, the Preliminary course began with cells, which was then followed by mammalian and plant physiology. Ecology was the final taught unit. The content suited the academic needs of average students who found the subject matter interesting. Participants were of the view that the order of units in this syllabus was correct and married with one of their views about how biology ought to be taught, that is, the teaching of biology ought to begin at the microscopic level and then move towards the macroscopic level. As one teacher commented:

> We started off with cells. Started off with the simple and went to the more complex ... we're just doing it in this order. Teacher E

However, teachers did differ in what they believed the syllabus could do for the more able students - this was dependent on the diversity of the school and the academic interest of students. Teachers with very able students felt that their students were not extended sufficiently - the syllabus was narrow in its formal approach and did not offer sufficient conceptual challenges for these able students who often lost interest and enthusiasm for the subject. Those teachers who perceived the syllabus as being flexible and, indeed the nature of biology as being in a state of constant change

as a result of biological research, believed that the syllabus boundaries were flexible and so they were able to incorporate recent research into their day to day biology teaching. Typical of such views was talk such as:

> Okay, I will teach that (what is on the syllabus) but then at the same time I'll do whatever else I fancy. You know if I read the Scientific American or something and think, wow! That was really interesting about cloning - Dolly. Now that is not in the syllabus ... I think any syllabus is flexible. Teacher M

Views concerning practical work differed. For the most part teachers found the mandatory practicals useful in guiding students in their learning and in the acquisition of biological skills. Nevertheless, the nature and amount of practical work differed between the Preliminary and the HSC years - skills developed in the Preliminary year were not further developed in the HSC year as evident in the following remarks:

> I've found that there is a lot more hands-on biological skills type prac work things to do, more in the Preliminary rather than HSC. When you're looking at ... when you start cells and then plants and mammals ... there's just so much hands-on practical work. But then when you get into the core of the HSC course they're not as easily get at able! The Human Species topic - that is really hard to do as a so-called prac work. And disease, the same sort of thing there. I mean there are a lot of things there you can do, but playing around with cultures and plates does have its hazards and we've been really warned about that so you take a step back a bit. The evolutionary type side of things is not really ... doesn't really lend itself to prac work ...you dig out the fossils and they play with the things and bits and pieces. But there's not much so-called ... I call it test tube prac work. Teacher B

The main criticism of this syllabus was that it did not contain any formal reference to current biological research. For example, it was devoid of any significant mention of biotechnology as explicated by one teacher as follows:

> There's change happening out there in the scientific world that I think as teachers we need to be aware of ... as educators we need to be aware of. We can't just think that things don't change because they are. And after printing off the Internet list of all the biotechnological advances in science from 1977 to 1999, it's quite incredible what's happened in that short space of time. And to think that none to these things appear in the old syllabus and considering that some of these advances were happening in 1977! Teacher W

Indeed for another teacher, the syllabus because of its familiarity did not require them to extend their personal understanding about biology. In contrast the new Stage 6 Biology syllabus was seen as a welcomed, intellectual challenge:

> It doesn't lend itself as ... I suppose it depends on me in a lot of ways. Whether I'm being pushed to go out and expand my horizons. But the old syllabus doesn't really encourage me to do that. But looking through the new one, it does. You've got to. You've got to get in there and look ... the new syllabus does really bring it all up. Teacher B

For these participants, syllabus change was viewed as a necessity, primarily because the biology presented to students ought to be current and of interest. For these reasons, topics for inclusion in any future syllabus such as biotechnology, cloning, genetically modified foods and the human genome project were essential. For as one participant remarked:

> ... it's great to look at the new endeavours and adventures and what's happening as well. Teacher H

The Stage 6 Biology syllabus (1999)

This syllabus aims to provide students with knowledge and understanding about fundamental biological concepts concerned with life, the historical development of these concepts and their application to society, technology and the environment. Moreover, it seeks to develop in students an understanding of biological models and language through the skill of communication and, a positive attitude to all aspects of the discipline including its epistemology (Stage 6 Biology Syllabus, p. 8).

All teachers in this study believed that substantial revisions to the previous syllabus were needed in order to capture the essential features of contemporary research, the nature of science and to foster students' interest in the subject. Asked to comment in general terms about this syllabus, characteristic responses included:

> Well it keeps me up to date and the kids. Courses have got to move with the times as well and there's still a lot of basic stuff there that's the basic building blocks that really have to be taught. Teacher A

It would seem then that fundamental biological concepts were still included. Close examination of this syllabus shows that the overarching concept in the Preliminary course is evolution within the context of Australian biota. This is a substantial shift in syllabus conceptualisation from the previous syllabus whose Preliminary focus centred on plant and animal physiology and function.

For those teachers with a long career in teaching, syllabus change was perceived to be slightly more problematic albeit inevitable. Their hesitation about embracing change and the inevitability of change was reflected in comments such as:

> The whole thing (referring to change in syllabus) worries me. Probably ... mainly because I don't like change. I thought things were going quite well. But it is just a new thing. It's happened so quickly. We haven't had a whole lot of support and the support, like the programs that have come through. So, there hasn't been a lot of time to think and really prepare for it. And I think there is quite a bit of anger about the whole thing. But people will get used to it. Like any new syllabus. Teacher E

At the same time that the syllabus was released to school, the Department of Education and Training began the task of providing professional development seminars where teachers were provided with further information about the syllabus and given the opportunity to program units of work and to seek guidance. These staff development sessions known as local interest group event (LIG events) were often conducted by classroom teachers who had received training from DET and presented these events on their behalf. One participant who was involved with a biology LIG event commented:

> They (referring to DET) had a two-day training session which was fairly general, but they didn't cover everything that we needed to cover at the LIG event. And I still felt pretty much in the dark when I left following those two days. And I was a bit worried giving the LIG event ... and all this PFAs and all that business. People don't understand that and they're just all new terms that they didn't feel comfortable with. When they started cutting up a (module) from the syllabus and putting it in towards a program and introducing skills and all that stuff they felt a bit more comfortable ... I think they've put people like us in there as a sort of a barrier to the anger (referring to teachers' disquiet about the pace of syllabus change). Teacher E

Another concern felt by teachers was that not all staff were given the opportunity to attend professional development session conducted by DET. For many participants it was the Head Teacher Science or another member of staff who had attended and they then debriefed colleagues at a subsequent staff meeting. A concern expressed by the following:

> With the LIG events, the fact that only some staff are given the opportunity to actually go. It would have been better if they had made it available for

more staff. I think that that was the problem with it. Teacher D

For teachers who attended, reactions were mixed. Those who had already spent time with colleagues familiarising themselves with the document and planning programs for 2000, the event allowed them to exchange ideas with others:

> And so therefore I found the LIG event not very useful. There was a couple of things I got which was quite good in terms of the structure of the syllabus that I hadn't realised before that had been pointed out to me. But it was useful to get ideas from other teachers from other schools. It's also good to go to a LIG event and ask questions to the Board of Studies and DET representatives ... Teacher M

For other teachers who were themselves involved at a local level through their own network of teachers, the value of such professional development seemed limited:

> I don't ... I shouldn't say this - it sounds terribly arrogant, but I don't think ... I think that ... it was airy-fairy. I think the idea was to show us methods of looking at a syllabus and how to program from it. But for a lot of us ... that's not a hassle. Teacher H

Preparation of programs and planning details concerning assessment and availability of teaching resources were a real concern for many participants. At the time of the first interview many teachers had already made overall plans for teaching the Preliminary course in 2000 and were now engaged in more detailed programming of the first module. This was either the Local Ecosystem or Patterns in Nature - the choice influenced either by teaching preferences or school timetabling arrangements. Most teachers had made the decision to begin with Ecology for no other reason than it was the first prescribed unit of study:

> You look at something and you say yeah that looks great, that looks good. And you run with it and then after you've run with it you think whoa! And that is the stage I'm at the moment. I've read it through, I've spent hours pondering through it, I've written some parts of programs put in bits and pieces in it and I've thought Okay, yep, I'm willing to give it a go. It looks great, it's going to push me a bit further which is good. Teacher B

In contrast there were other teachers who had never programmed at the senior level and had used the syllabus as the program itself. For these participants, there was simply no need to program again because the Stage 6 Biology syllabus was so prescriptive and detailed as to render the task unnecessary:

> What I found though is this ... the actual syllabus is so detailed you could even run with that. Teacher A

Asked about the usefulness of programs made available by the Board of Studies on the Internet in December 1999, teachers replied that they were helpful merely as a guide and changes would need to be made to suit their individual teaching circumstances. The list of Internet sites was cited as helpful particularly as there were no textbooks. Moreover, concerns remained as to the required depth and breadth of coverage which in the past was assessed from examination papers:

> I thought it (1996 syllabus) was concise. It wasn't as detailed as this (Stage 6 Biology) and therefore there was a lot of doubts as to what you actually had to teach. *But then you looked at an exam paper and you taught to the exam, to see to what depth you have to do it* . Teacher D

> The old one being brief, specific, clear as I said before - *taught by exams really. That's what we referred to, to decide what depth you go into* . The new one is complex. Teacher F

Another item raised by teachers was the issue of timing, that is, the amount of subject matter and skills which needed to be covered in the allocated 120 hours. Because the syllabus was seen both as prescriptive and content dense, it was not surprising that many teachers' immediate concerns focused on the practicalities of the Preliminary course rather than on preparing students for the final HSC examination as typified by:

> It's just the time factor that worries me. I can't, if I want to fit it all in the first three terms, I can start Year 12 in term four. It is going to be a squash. You can't get it done in 120 hours. I mean, 120 hours doesn't fit in the first three terms. And no one (inferring the Board of Studies) has ever addressed that. 120 hours doesn't fit into three terms. That's all there is ... it just doesn't fit. Teacher S

Further, such concerns were replaced by others during the later part of the year. These were assessment, administration and accountability (Interview 3).

Maintaining viable student numbers in biology was a concern for many teachers. Students were not choosing biology because of lack of interest rather they were moving out of science generally and into computer and business studies, subjects perceived by students as easier than science for scoring high examination marks. Interestingly, this was not the case in one of the selective schools - here numbers in biology were on the rise because it was seen as a subject where students could score 100 on the examination and use this mark as a basis for university entrance into courses such as medicine, law and information technology.

What students found the most interesting were topics which directly concerned them. Not surprisingly, teachers cited human disease as the most popular area of study for students and so welcomed its new position as a mandatory unit of study. Previously it was an elective unit. In contrast, students were not so much interested in evolution, ecology and Australian biota found in the Preliminary course. Other areas of student interest were human physiology and function along with biotechnology - topics now housed in the HSC course. What students were expecting to learn were topics dealing with their own biology and when this did not occur in the school where Teacher K's taught " ... students voted with their feet." The fact that science at the HSC level was undergoing change was not seen always by this teacher or colleagues as a positive step towards maintaining student numbers.

The Internet was seen by these participants are the 'saving grace'. For those teachers who used it on a regular basis, the Internet provided them with much of the information they needed particularly for less familiar topics such as biotechnology and biochemistry. Apart from two teachers, all had Internet access at home and used it as an integral part of their day to day lesson preparation. At school Internet access was in the library or in a designated computer room. Only one school had an Internet/Intranet connection in the biology laboratory but this was a serendipodous acquisition. What concerned teachers was the lack of money/resources for lab access.

For other technologies, including data loggers and CDROM packages, reactions from teachers were mixed. Some welcomed the availability of these resources as useful aids to student learning whilst others dismissed data loggers in particular as adding no value to learning. Traditional apparatus continued to serve their teaching purposes despite mention being made in the Stage 6 Biology syllabus of IT.

> P12.2 a) gather first-hand information by using appropriate data collection techniques employing appropriate technologies, including data loggers and sensors. (p.12)

Funds for the purchase of data loggers and probes were made available to government schools during 2000. Whilst some schools had purchased probes, graphics calculators and related software packages others had not addressed the use of technologies or considered them in teaching.

Few teachers were completely comfortable with IT. Many were making a concerted effort to become familiar with its use and felt that maturation time was needed for a clear understanding of its teaching/learning potential. It was not the case that teachers simply refused to acknowledge the potential value of IT. What teachers wanted was time to think through various applications for each probe for example at the same time as they were becoming more conversant with the demands of the syllabus. This was been a consistent view of IT throughout the study. As two teachers noted:

> It (technology) is good. I want to get into it. I really want to know how to use all of this because I can see ... I've got so many pracs that I just want to run using the data loggers and what have you and at school here - the probes and the whole lot. Teacher B

> ... introducing things like data loggers and stuff like that, I think that's quite important and being able to research properly using good places for references, like Internet for example and CD ROMs and stuff. They have to include that. And I think if they don't specify it, some people will not do it by that method. Teacher M

New and often unfamiliar areas of biology in the Stage 6 syllabus were not a concern for teachers. Many welcomed these areas of study because they reflected the status of biological research. Students were entitled to an education in biology which reflected some of the most notable areas of recent biological development. Biotechnology, the human genome project, genetically modified foods and some aspects of the evolution of Australian biota notably the discovery of the Wollembi pine, were seen as a challenge and of interest to them as science teachers. New areas of research in biology were not the issue nor teachers' understanding of the syllabus content, what participants were concerned about initially were questions relating to practicality, that is, where could information be obtained in a format which teachers could make accessible to students. It was here that the Internet was helpful given the paucity of HSC biology texts.

Concluding Remarks

This paper has outlined some of the concerns a group of experienced biology teachers have about syllabus change. All were of the view that changes were needed to the 2-Unit Biology Syllabus (1994) in order that students be provided with a course of study at senior secondary school level which reflected some of the more recent developments in biology. How this was done and the extent to which teachers thought this necessary differed. For those teachers, who had and continued to think about the syllabus as being flexible both in its approach and content, significant changes were probably not necessary. Many of the aims and objectives of the Stage 6 Biology syllabus were already part of their previous teaching practice. For others who thought of the 1994 syllabus as bounded, changes were welcomed. However, for many teachers close examination of the Stage 6 syllabus revealed it to be content rich and thus somewhat problematic in terms of available time.

Recent research (November/December 2000) seems to indicate that many of the initial concerns about the Stage 6 syllabus - programming, timing, resources - have been resolved. Others such as the use of technology were being addressed on a regular basis. Issues relating the assessment, practical examination and preparation for the HSC course were now at the forefront of teachers' thinking. The most significant findings to date were that teachers have resigned themselves to syllabus change and have undertaken what might be termed 'domestication', a process whereby slight adjustments to teaching practice take place whilst adhering to syllabus demands at a minimal level. Given that many teachers felt syllabus change was too quick, this adjustment might well serve as a coping strategies whereby stress and unease can be avoided. Further research will explore such mechanisms and related issues.

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Appendix 1: Recommendations

Symposium Recommendations

Following the symposium, the Science 7-12 Syllabus Advisory Committee made recommendations to guide the writing briefs. The recommendations (R1...R24) were endorsed by the Board in June 1998 and are summarised below:

- Biology, Chemistry, Geology, Physics and General Science are single courses (R1, R2) and the Preliminary course in Biology, Chemistry, Geology or Physics will be accepted as the Preliminary course for Applies Science, provided that the student transfers from one of the aforementioned courses into General Science (R3);
- Stage 6 courses recognise and build upon learning and skills developed in Years 7-10 (R4) and further develop appropriate skills in information gathering, analysing, problem-solving and other key competencies (R5);
- the structure of courses be sufficiently flexible so as to cater to needs of a wide range of students (R6) with either a core and options or a modular structure (R7);
- the amount of material in the course be able to be realistically addressed in 240 hours at a depth that is consistent with the outcomes (R8);
- the content of courses include current science and the contribution of Australian scientists and technologies 9R9) and address the interdisciplinary nature of science (R11);
- consideration be given to providing the facility within the course structure for the content to be regularly updated (R10) and to the development of multidisciplinary options which may be common to a number of courses (R12);
- courses include an emphasis on 'hands on' practical work with an appropriate amount of mandatory practical and field work experiences (R13), with these activities being an integral part of the knowledge and understandings of each course (R14);
- courses include a range of contexts as part of content (R15). Concepts should be taught within contexts relevant to students' lives and interests that assist students in acquiring scientific literacy (R16);
- courses include a student-centred/directed research project in each course in which students are involved in using scientific skills and developing attitudes (R17);
- vocational education links or options be included and that the possibility of advanced standing with tertiary providers be explored (R18), and that courses incorporate the appropriate use of information technology (R23);
- a variety of assessment tools be designed to support the intent and philosophy of each syllabus (R19) and that assessment not dictate structure and scope of the courses (R20);
- syllabuses be accompanied by a comprehensive support document (R21) and the Office of the Board of Studies liase with systems' authorities with respect to issues raised about support for implementation (R22);
- consideration be given to changing the name of some courses, particularly Geology, Biology and General Science, so that the name better reflects the nature and content of the course (R24).

Reference:

Board of Studies NSW (1998). Science stage 6 draft syllabus writing brief.

Literature Review Recommendations

Additional recommendations (LR1...LR20) have been drawn from the literature reviews and will also guide the development of the writing briefs. Recommendations 1-12 are common to each syllabus while Recommendations 13-20 apply to the specific syllabus identified in the recommendation. Some of these recommendations provide support for those drawn from the Symposium. The literature review recommendations are summarised below:

- The content of each course emphasise the importance of engaging the student intellectually, stimulating interest in the principles and processes of the subject by showing the application and relevance of the content (LR1);
- The course content provide students with the opportunity to develop a positive attitude towards the subject and value the role the subject plays in their lives and in meeting the needs of humankind as it faces future challenges (LR2);
- The course present students with a wide range of activities that allow students to take responsibility for their own learning (LR3);
- The course content allow students to practise critical thinking and problem solving by applying the knowledge and understanding to real life contexts (LR4);
- The course content allow students to critically examine current and future issues in the subject within a framework of their own value system and that of the wider community (LR5);
- The course content provide students with the opportunity to develop science literacy skills (LR6);
- The course content consist of a framework covering a small number of core concepts that are more thoroughly understood (LR7), incorporate conceptual themes relevant to the curriculum (LR8) and recognise the multidisciplinary nature of many aspects of the discipline (LR9);
- The support document and in-service training provide teachers with the opportunity to critically evaluate their own perceptions about the study of the subject, what concepts are involved, what functions the subject serves in society and how students understand its concepts (LR10);
- The course develop skills and a positive attitude towards using a variety of teaching/learning strategies. These will include practical work, games, case studies, original research projects, verbalising preconceptions, various writing tasks, drawing, modelling, analogies, computer-based learning, and collaborative learning (LR11). The in-service training model should use the same learning strategies for teachers (LR12);
- The structure of the biology courses reflect the integration, sequence and continuity of biological concepts with an emphasis on biochemistry, physiology and ecology (LR13). The literature suggests the following areas be considered for inclusion in a contemporary biology course: diversity and unity of origin, biodiversity, ecology, DNA/molecular biology, maintenance of life through regulation and homeostasis, energy in biological systems, what

constitutes a balanced environment, the unique role of humankind in nature, the biologically and psychologically integrated human body;

- The literature suggests that biochemistry, environmental chemistry, consumer chemistry, forensic science and industrial chemistry be considered for inclusion in a contemporary chemistry course (LR14);
- Gender issues be considered in the development of the physics course to address an under representation of girls (LR16). The literature suggests the following areas be considered for inclusion in a contemporary physics course: particle physics, quantum optics and quantum mechanics (LR15);
- The earth sciences be broadened to include initiatives in atmospheric and space science and oceanography (LR17) and be integrated with issues related to natural resources, environmental quality and natural hazards (LR18);
- An analysis of courses undertaken by students in the current Science for Life and General Science courses after they leave school indicates that the structure of the new General Science course should reflect the importance of practical skills, instrumentation, information technology and communication (LR19) and the following areas of science should be considered for inclusion in that course: knowledge and understanding of basic principles and concepts of Biology, Chemistry, Earth Science and Physics as they relate to the study of health, the environment and the use and management of resources (LR20).

Appendix 2: Areas for Discussion in Interviews

Interview 1:

- Word of thanks
- Demographics details of each participant
    - Years of teaching, schools
    - Science taught at the science level
    - Other relevant details as they arise
- Discussion of the 1996 HSC biology syllabus - aims, objectives, content, relevance and interest to students, areas for development
- General description of what it means to teach biology from a professional and personal perspective
- Views about the nature of biology per se and how this is/ought to be portrayed in biology courses for senior students at high school
- Views on the Stage 6 syllabus - events leading up to its development and subsequent release to school for implementation in 2000, hopes, expectations and possible concerns concerning its implementation, syllabus rationale, aims, outcomes, subject matter and biological skills
- Professional support both within and out of school
- Other as raised by the participant during the interview.

Interview 2:

- Word of thanks
- Review of the last interview and invite the participant to comment on some of the more general initial findings and those of their own transcript
- Stage 6 Biology syllabus
    - Topics covered so far, their content - knowledge, skills, practical work, student difficulties etc.
    - Programming, timing, lesson organisation
    - Collection, collation and use of resources in particular IT
    - Reaction of students compared with previous year
    - Highlights and difficulties
- Personal/professional needs
- Goals for students
- Other comments as appropriate